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Baker et al.

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(54) **MECHANISM FOR FACILITATING EVALUATION OF DATA TYPES FOR DYNAMIC LIGHTWEIGHT OBJECTS IN AN ON-DEMAND SERVICES ENVIRONMENT**

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(60) Provisional application No. 61/625,746, filed on Apr. 18, 2012, provisional application No. 61/639,157, filed on Apr. 27, 2012, provisional application No. 61/640,476, filed on Apr. 30, 2012, provisional application No. 61/640,483, filed on Apr. 30, 2012, provisional application No. 61/640,487, filed on Apr. 30, 2012, provisional application No. 61/640,495, filed on Apr. 30, 2012.

(51) **Int. Cl.**
G06F 17/30 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 17/30091*** (2013.01); ***G06F 17/30705*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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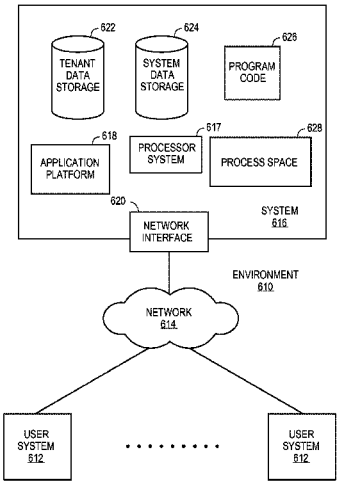
(57) **ABSTRACT**

In accordance with embodiments, there are provided mechanisms and methods for facilitating evaluation of data types for dynamic lightweight objects in an on-demand services environment. In one embodiment and by way of example, a method includes uploading a data file having data at a first computing device in response to a request, and detecting data types relating to the data within the data file. The detecting includes scanning data rows and data columns of the data file. The method may further include classifying the detected data types into one or more categories, and creating one or more dynamic objects based on the one or more categories.

18 Claims, 9 Drawing Sheets



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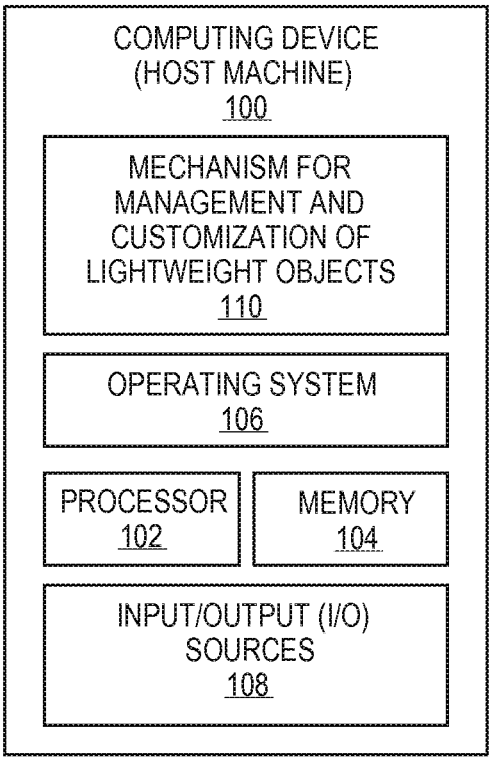
COMPUTING DEVICE
(HOST MACHINE)
100
MECHANISM FOR
MANAGEMENT AND
CUSTOMIZATION OF
LIGHTWEIGHT OBJECTS
110
OPERATING SYSTEM
106
PROCESSOR
102
MEMORY
104
INPUT/OUTPUT (I/O)
SOURCES
108

FIG. 1

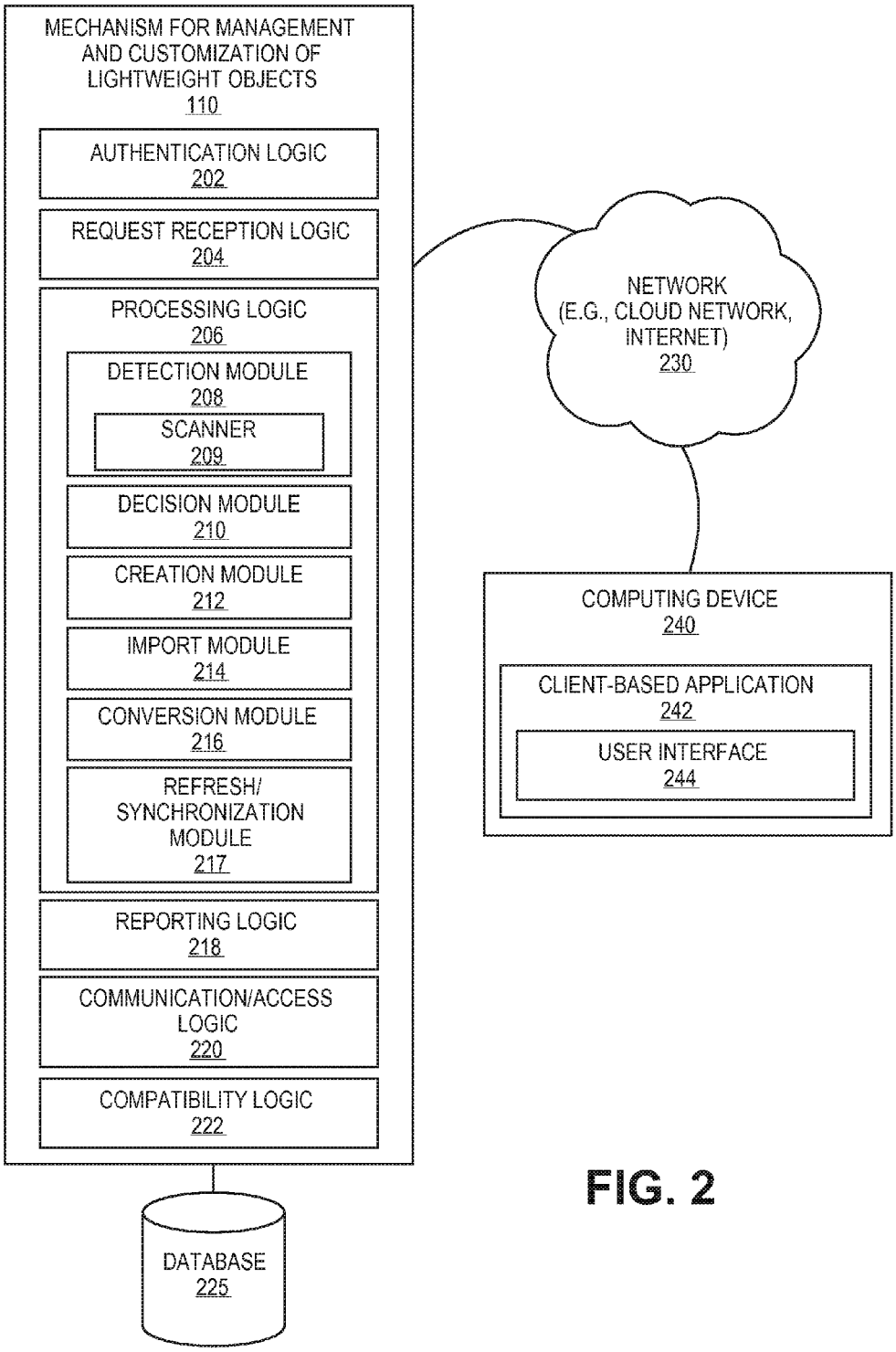
MECHANISM FOR MANAGEMENT AND CUSTOMIZATION OF LIGHTWEIGHT OBJECTS
110
AUTHENTICATION LOGIC
202
REQUEST RECEPTION LOGIC
204
PROCESSING LOGIC
206
DETECTION MODULE
208
SCANNER
209
DECISION MODULE
210
CREATION MODULE
212
IMPORT MODULE
214
CONVERSION MODULE
216
REFRESH/ SYNCHRONIZATION MODULE
217
REPORTING LOGIC
218
COMMUNICATION/ACCESS LOGIC
220
COMPATIBILITY LOGIC
222
DATABASE
225
NETWORK
(E.G., CLOUD NETWORK, INTERNET)
230
COMPUTING DEVICE
240
CLIENT-BASED APPLICATION
242
USER INTERFACE
244

FIG. 2

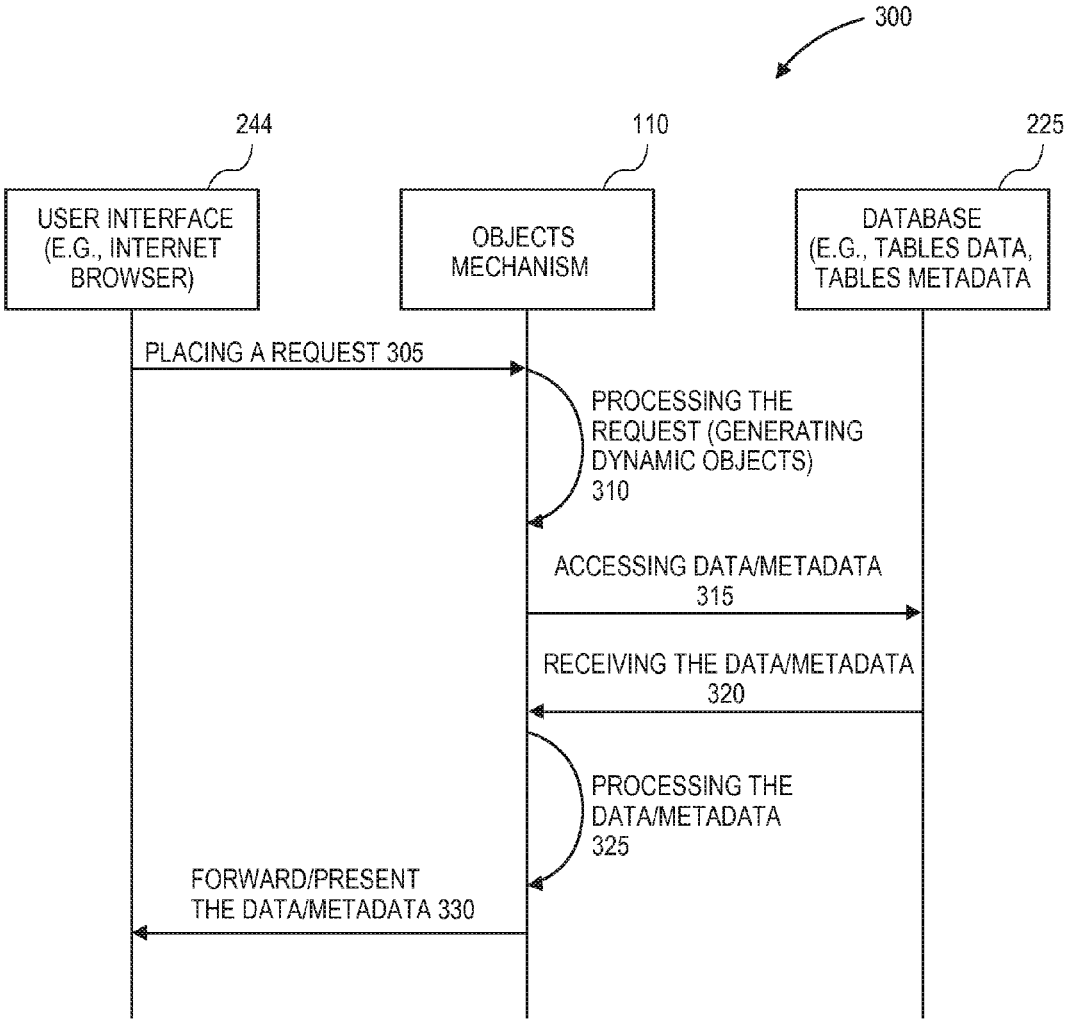
300
244
110
225
USER INTERFACE (E.G., INTERNET BROWSER)
OBJECTS MECHANISM
DATABASE (E.G., TABLES DATA, TABLES METADATA
PLACING A REQUEST 305
PROCESSING THE REQUEST (GENERATING DYNAMIC OBJECTS) 310
ACCESSING DATA/METADATA 315
RECEIVING THE DATA/METADATA 320
PROCESSING THE DATA/METADATA 325
FORWARD/PRESENT THE DATA/METADATA 330

FIG. 3

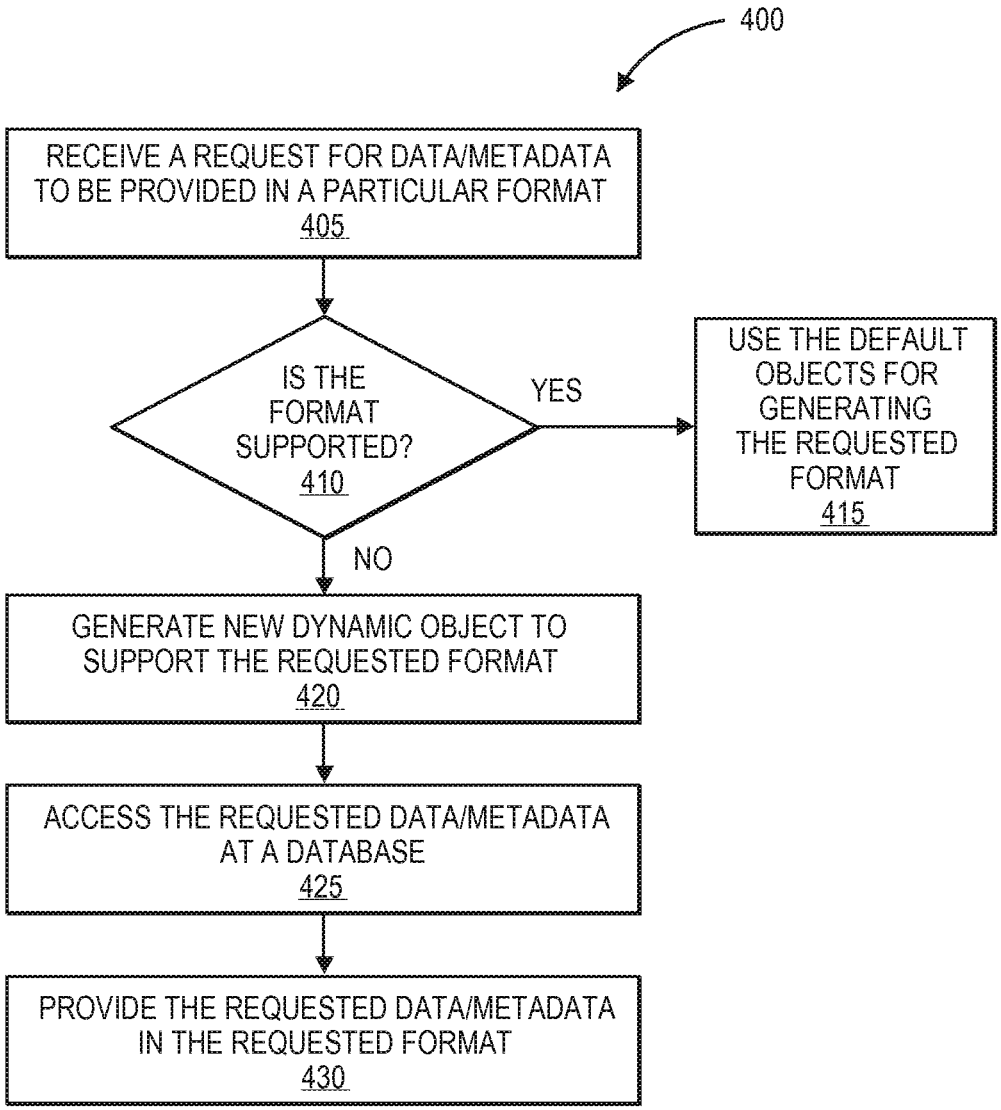
400
RECEIVE A REQUEST FOR DATA/METADATA TO BE PROVIDED IN A PARTICULAR FORMAT
405
IS THE FORMAT SUPPORTED?
410
YES
USE THE DEFAULT OBJECTS FOR GENERATING THE REQUESTED FORMAT
415
NO
GENERATE NEW DYNAMIC OBJECT TO SUPPORT THE REQUESTED FORMAT
420
ACCESS THE REQUESTED DATA/METADATA AT A DATABASE
425
PROVIDE THE REQUESTED DATA/METADATA IN THE REQUESTED FORMAT
430

FIG. 4

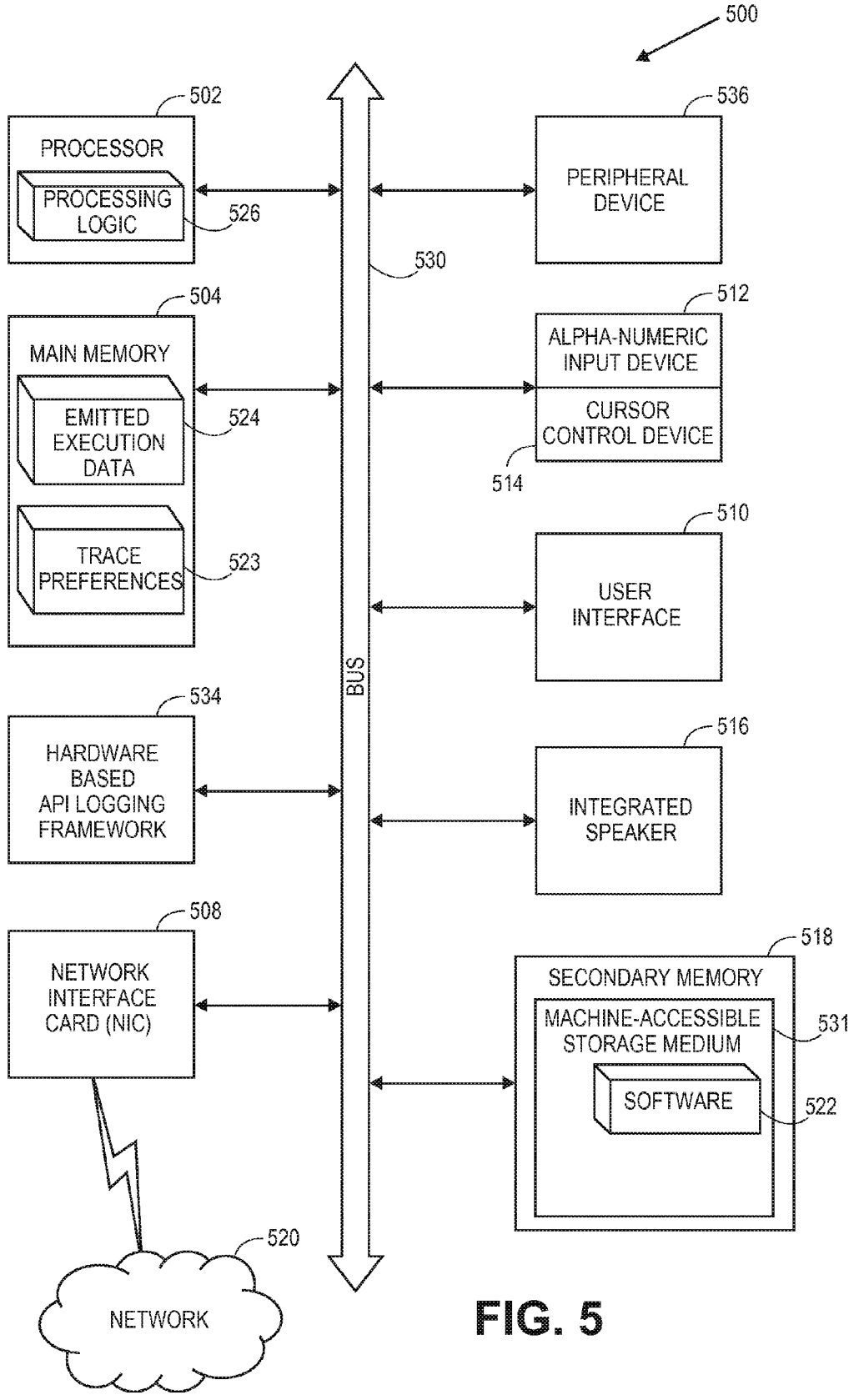
500
502
PROCESSOR
PROCESSING LOGIC
526
504
MAIN MEMORY
EMITTED EXECUTION DATA
524
TRACE PREFERENCES
523
534
HARDWARE BASED API LOGGING FRAMEWORK
508
NETWORK INTERFACE CARD (NIC)
520
NETWORK
BUS
530
536
PERIPHERAL DEVICE
512
ALPHA-NUMERIC INPUT DEVICE
CURSOR CONTROL DEVICE
514
510
USER INTERFACE
516
INTEGRATED SPEAKER
518
SECONDARY MEMORY
MACHINE-ACCESSIBLE STORAGE MEDIUM
531
SOFTWARE
522

FIG. 5

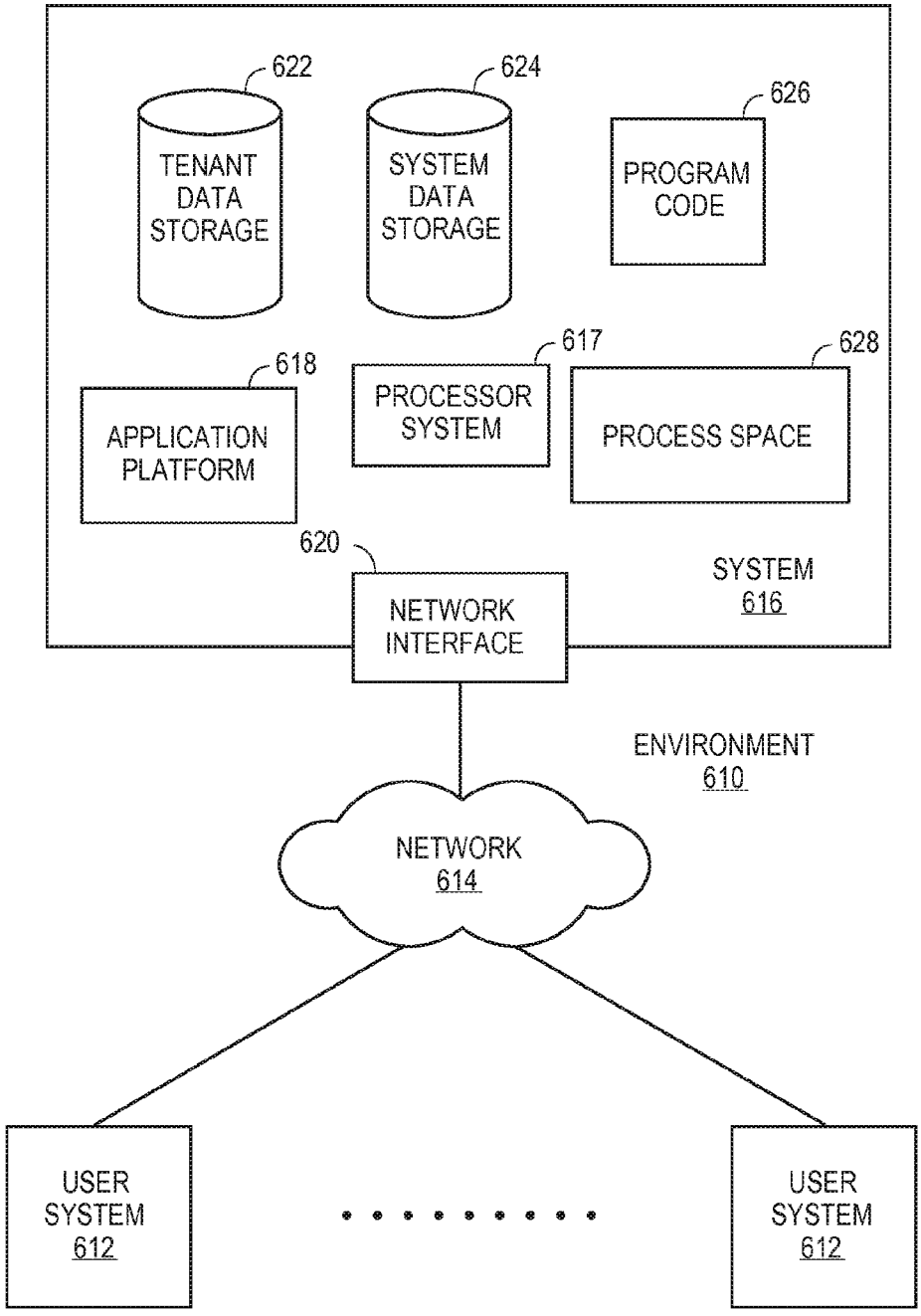
622
624
626
TENANT DATA STORAGE
SYSTEM DATA STORAGE
PROGRAM CODE
618
617
628
APPLICATION PLATFORM
PROCESSOR SYSTEM
PROCESS SPACE
620
SYSTEM 616
NETWORK INTERFACE
ENVIRONMENT 610
NETWORK 614
USER SYSTEM 612
USER SYSTEM 612

FIG. 6

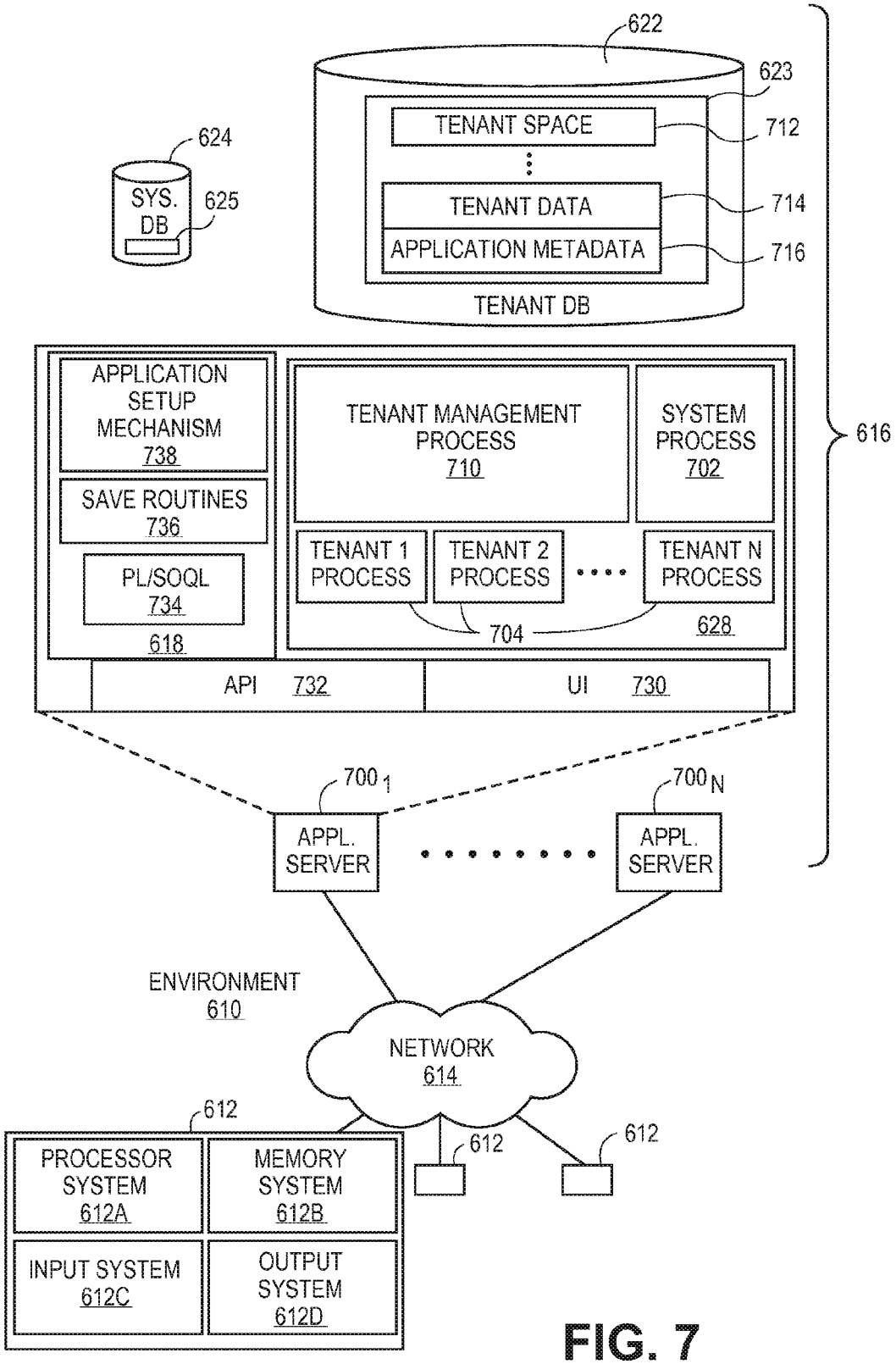
622
623
TENANT SPACE
712
TENANT DATA
714
APPLICATION METADATA
716
TENANT DB
624
SYS. DB
625
APPLICATION SETUP MECHANISM 738
SAVE ROUTINES 736
PL/SOQL 734
618
TENANT MANAGEMENT PROCESS 710
SYSTEM PROCESS 702
TENANT 1 PROCESS
TENANT 2 PROCESS
TENANT N PROCESS
704
628
API 732
UI 730
616
700 1
700 N
APPL. SERVER
APPL. SERVER
ENVIRONMENT 610
NETWORK 614
612
612
612
PROCESSOR SYSTEM 612A
MEMORY SYSTEM 612B
INPUT SYSTEM 612C
OUTPUT SYSTEM 612D

FIG. 7

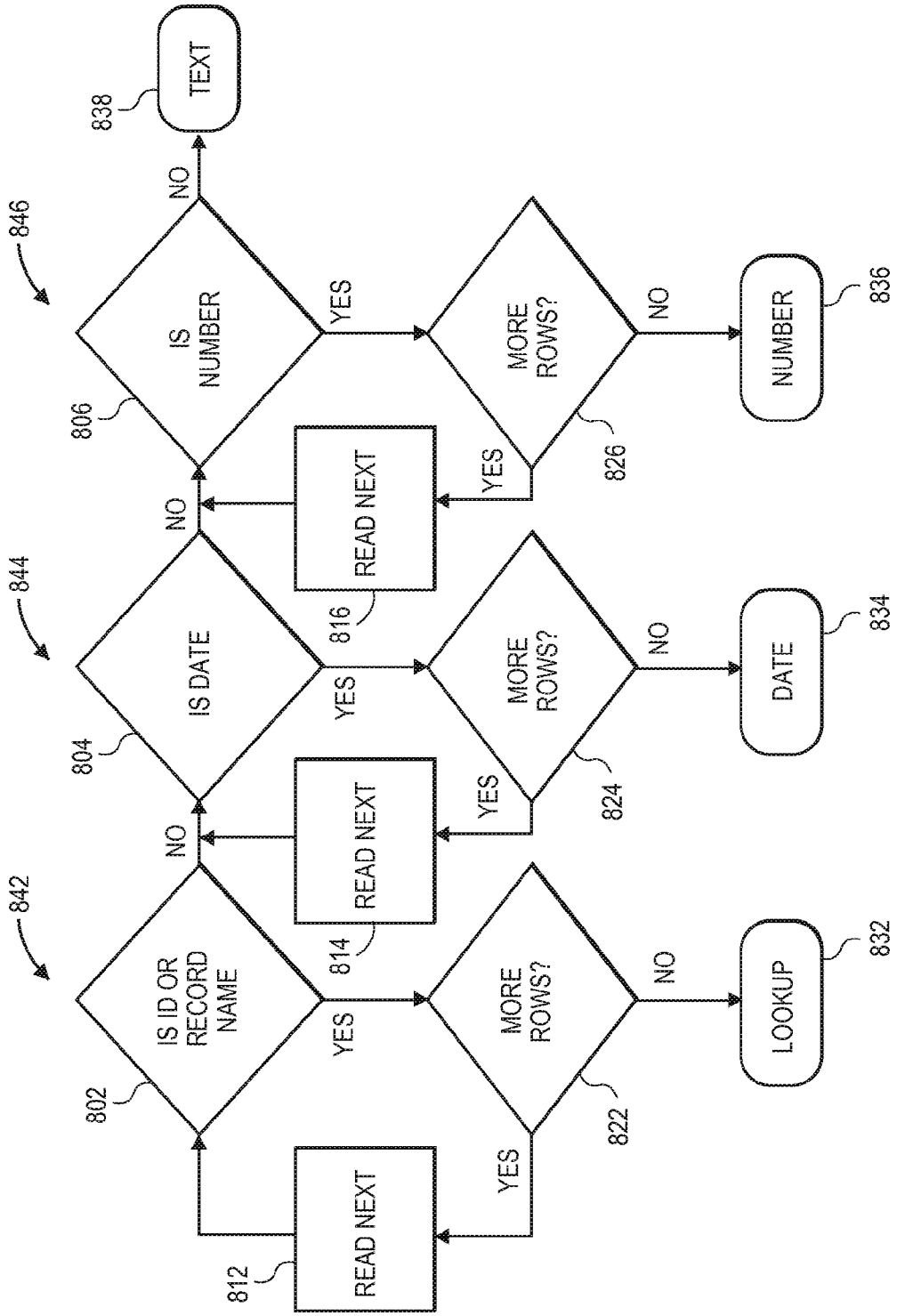
842
844
846
802
IS ID OR RECORD NAME
YES
NO
812
READ NEXT
814
READ NEXT
816
READ NEXT
804
IS DATE
806
IS NUMBER
822
MORE ROWS?
824
MORE ROWS?
826
MORE ROWS?
NO
YES
LOOKUP
832
DATE
834
NUMBER
836
TEXT
838

FIG. 8

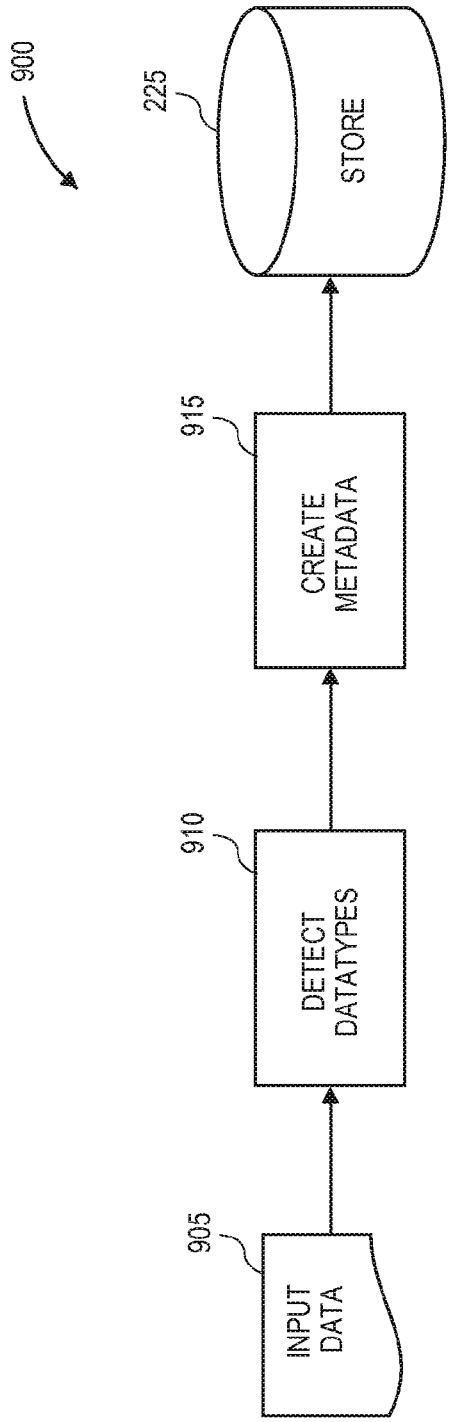
900
225
STORE
915
CREATE METADATA
910
DETECT DATATYPES
905
INPUT DATA

FIG. 9A

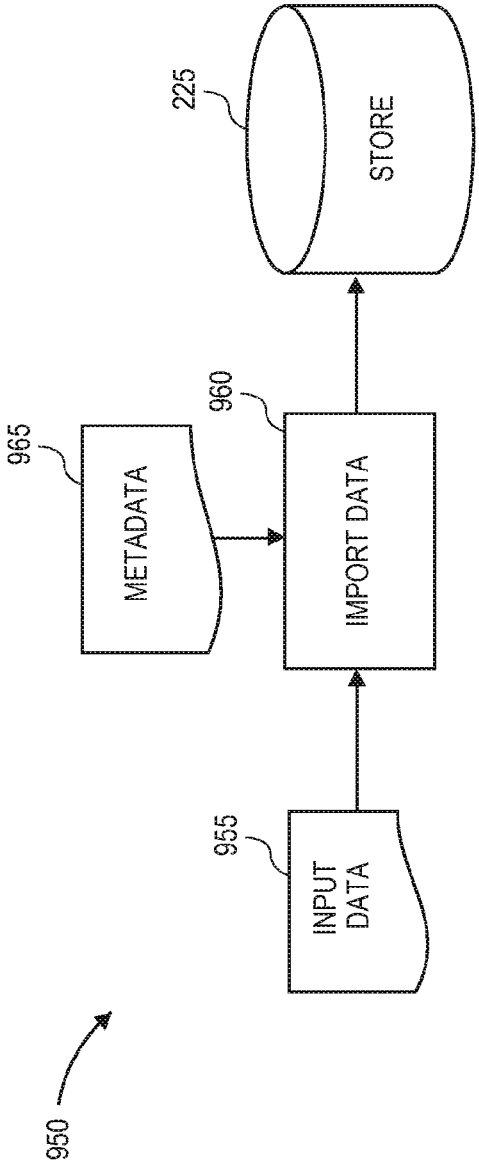
225
STORE
960
965
METADATA
IMPORT DATA
955
INPUT DATA
950

FIG. 9B

MECHANISM FOR FACILITATING EVALUATION OF DATA TYPES FOR DYNAMIC LIGHTWEIGHT OBJECTS IN AN ON-DEMAND SERVICES ENVIRONMENT

CLAIM OF PRIORITY

This application is a continuation application of U.S. patent application Ser. No. 13/691,452, entitled "MECHANISM FOR FACILITATING EVALUATION OF DATA TYPES FOR DYNAMIC LIGHTWEIGHT OBJECTS IN AN ON-DEMAND SERVICES ENVIRONMENT", by Gary Baker, et al., filed Nov. 30, 2012, now allowed, which claims the benefit of and priority to U.S. Provisional Patent Application No. 61/625,746, entitled "METHODS AND SYSTEMS FOR CREATING LIGHTWEIGHT CUSTOM OBJECTS IN AN ON-DEMAND SERVICES ENVIRONMENT" by Gary Baker, filed Apr. 18, 2012, and U.S. Provisional Patent Application No. 61/639,157, entitled "METHODS AND SYSTEMS FOR EVALUATING A DATA TYPE IN A LIGHT-WEIGHT CUSTOM OBJECT" by Gary Baker, et al., filed Apr. 27, 2012, and U.S. Provisional Patent Application No. 61/640,476, entitled "METHODS AND SYSTEMS FOR EFFICIENT UPLOADING OF OBJECT DATA" by Gary Baker, et al., filed Apr. 30, 2012, and U.S. Provisional Patent Application No. 61/640,483, entitled "METHODS AND SYSTEMS FOR CREATING A TABLE" by Gary Baker, et al., filed Apr. 30, 2012, and U.S. Provisional Patent Application No. 61/640,487, entitled "METHODS AND SYSTEMS FOR CREATING A TABLE FROM A REPORT" by Gary Baker, et al., filed Apr. 30, 2012, and U.S. Provisional Patent Application No. 61/640,495, entitled "METHODS AND SYSTEMS FOR UPDATING A TABLE" by Frank Lopez, filed Apr. 30, 2012, the entire contents of all are incorporated herein by reference and the benefit of and priority to all is claimed thereof.

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TECHNICAL FIELD

One or more implementations relate generally to data management and, more specifically, to a mechanism for facilitating evaluation of data types for dynamic lightweight objects in an on-demand services environment.

BACKGROUND

Even with the growing use of databases, social network websites, etc., entities or objects offered by service providers are limited to a service provider's default entities and thus do not extend their users (e.g., customers of service providers, etc.) any significant level of customization control over their databases, tables, reports, files, etc.

The subject matter discussed in the background section should not be assumed to be prior art merely as a result of its mention in the background section. Similarly, a problem mentioned in the background section or associated with the subject matter of the background section should not be assumed to have been previously recognized in the prior art.

The subject matter in the background section merely represents different approaches.

In conventional database systems, users access their data resources in one logical database. A user of such a conventional system typically retrieves data from and stores data on the system using the user's own systems. A user system might remotely access one of a plurality of server systems that might in turn access the database system. Data retrieval from the system might include the issuance of a query from the user system to the database system. The database system might process the request for information received in the query and send to the user system information relevant to the request. The secure and efficient retrieval of accurate information and subsequent delivery of this information to the user system has been and continues to be a goal of administrators of database systems. Unfortunately, conventional database approaches are associated with various limitations.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following drawings like reference numbers are used to refer to like elements. Although the following figures depict various examples, one or more implementations are not limited to the examples depicted in the figures.

FIG. **1** illustrates a computing device employing a mechanism for facilitating management and customization of lightweight objects according to one embodiment;

FIG. **2** illustrates a mechanism for facilitating management and customization of dynamic lightweight objects according to one embodiment;

FIG. **3** illustrates a transaction sequence for facilitating management and customization of lightweight objects according to one embodiment;

FIG. **4** illustrates a method for facilitating management and customization of lightweight objects according to one embodiment;

FIG. **5** illustrates a computer system according to one embodiment;

FIG. **6** illustrates a block diagram of an environment wherein an on-demand database service might be used according to one embodiment;

FIG. **7** illustrates a block diagram of an embodiment of elements of environment of FIG. **6** and various possible interconnections between these elements according to one embodiment;

FIG. **8** illustrates detecting and evaluating a data type in an input data file for generating relevant lightweight dynamic custom objects according to one embodiment; and

FIGS. **9**A and **9**B illustrate processes in accordance with FIG. **8** according to one embodiment.

DETAILED DESCRIPTION

Methods and systems are provided for facilitating evaluation of data types for dynamic lightweight objects in an on-demand services environment. In one embodiment and by way of example, a method includes uploading a data file having data at a first computing device in response to a request, and detecting data types relating to the data within the data file. The detecting includes scanning data rows and data columns of the data file. The method may further include classifying the detected data types into one or more categories, and creating one or more dynamic objects based on the one or more categories.

As used herein, a term multi-tenant database system refers to those systems in which various elements of hardware and

software of the database system may be shared by one or more customers. For example, a given application server may simultaneously process requests for a great number of customers, and a given database table may store rows for a potentially much greater number of customers. As used herein, the term query plan refers to a set of steps used to access information in a database system.

Embodiments are described with reference to an embodiment in which techniques for facilitating management of data in an on-demand services environment are implemented in a system having an application server providing a front end for an on-demand database service capable of supporting multiple tenants, embodiments are not limited to multi-tenant databases nor deployment on application servers. Embodiments may be practiced using other database architectures, i.e., ORACLE®, DB2® by IBM and the like without departing from the scope of the embodiments claimed.

Next, mechanisms and methods for facilitating evaluation of data types for dynamic lightweight objects in an on-demand services environment will be described with reference to example embodiments.

FIG. **1** illustrates a computing device **100** employing a mechanism for facilitating management and customization of lightweight objects ("dynamic objects mechanism") **110** according to one embodiment. In one embodiment, computing device **100** serves as a host machine employing dynamic objects mechanism **110** for providing dynamic creation and management of lightweight objects for facilitating user-control of customization of user data as desired or necessitated by a user (e.g., a company, a corporation, an organization, a business, an agency, an institution, etc.). The user refers to a customer of a service provider (e.g., Salesforce.com) that provides and manages dynamic objects mechanism **110** at a host machine, such as computing device **100**.

Computing device **100** may include server computers (e.g., cloud server computers, etc.), desktop computers, cluster-based computers, set-top boxes (e.g., Internet-based cable television set-top boxes, etc.), and the like. Computing device **100** may also include smaller computers, such as mobile computing devices, such as cellular phones including smartphones (e.g., iPhone® by Apple®, BlackBerry® by Research in Motion®, etc.), handheld computing devices, personal digital assistants (PDAs), etc., tablet computers (e.g., iPad® by Apple®, Galaxy® by Samsung®, etc.), laptop computers (e.g., notebooks, netbooks, Ultrabook™, etc.), e-readers (e.g., Kindle® by Amazon.com®, Nook® by Barnes and Nobles®, etc.), Global Positioning System (GPS)-based navigation systems, etc.

Computing device **100** includes an operating system (OS) **106** serving as an interface between any hardware or physical resources of the computing device **100** and a user. Computing device **100** further includes one or more processors **102**, memory devices **104**, network devices, drivers, or the like, as well as input/output (I/O) sources **108**, such as touchscreens, touch panels, touch pads, virtual or regular keyboards, virtual or regular mice, etc. It is to be noted that terms like "node", "computing node", "client", "client device", "server", "server device", "cloud computer", "cloud server", "cloud server computer", "machine", "host machine", "device", "computing device", "computer", "computing system", "multi-tenant on-demand data system", and the like, may be used interchangeably throughout this document. It is to be further noted that terms like "application", "software application", "program", "software program", "package", and "software package" may be used interchangeably throughout this document.

FIG. **2** illustrates a mechanism for facilitating management and customization of dynamic lightweight objects **110** according to one embodiment. In one embodiment, dynamic objects mechanism **110** provides an infrastructure to support a larger than conventional to unlimited number of lightweight objects or entities (also referred to as "tables", "new objects", "custom objects", "dynamic custom objects", "dynamic objects", "my custom objects" or simply "MCOs") per tenant in a multi-tenant database for user-controlled customization of data and its presentation, while conventional objects or entities may be further referred to as "default objects", "administered custom objects", "administered objects", "default objects", "traditional objects", etc. For example, lightweight objects may be allowed to use larger identifier (ID) space (e.g., 15 chars) than the more conventional key_prefix space (e.g., 3 chars) to differentiate custom data by type and support an unlimited number of lightweight objects per tenant (as opposed to the default or administered objects that have a limited namespace of, for example, about 4000 types and an artificial limit to, for example, about 2000). Throughout the document, it is contemplated that embodiments permit supporting an unlimited number of custom objects per tenant or, in other words, within the context of a tenant, an unlimited number of tables are supported. Further, in one embodiment, lightweight objects may help load metadata "on the fly" along with actual data to avoid caching massive amounts of metadata to describe a rather large number of object types, while hiding the metadata from administrative views to avoid displaying too much clutter. Dynamic objects mechanism **110** may support this proliferation of object types by, for example, storing type IDs along with record IDs in the index as well as expanding the maximum size for a search bucket Id and further, allowing new lightweight objects to be sharable with the existing default objects in a private sharing model. The use of the term "lightweight", "tables", "my custom object" or "MCO" should not be read to limit embodiments to objects that carry that label in products or in literature external to this document. Terms like "objects" and "entities" may be used interchangeably throughout this document.

It is contemplated that an administrative user typically includes an authorized and/or trained user, such as a system administrator, a software developer, a computer programmer, etc. In contrast, an end-user may be any user that can access a client computing device, such as via a software application or an Internet browser. In light of this and in one embodiment, lightweight "tables" or "MCOs" differ from administered objects in that any number and type of tables/MCOs can be created per tenant or within a single tenant by end-users or non-administrative users, while conventional custom objects may only be created by administrative users and are limited to a particular amount, such as 2000 objects per tenant. Standard custom objects may be part of a service provider's default offering for all its customers (although some licensing restrictions may apply).

Dynamic object definitions may be stored in a standard_entity_data table, while, in contrast, custom entity definitions may be stored in a custom_entity_definition table. Any fields that are dynamically added to each dynamic object may be based on the fields in the imported file. For example, a user, via client computing device **240**, may access any number of MCOs (e.g., 65,536 MCOs) since each dynamic object entity may not have a unique key prefix that is stored in database **225**. Entity IDs for each loaded dynamic object may be dynamically calculated when dynamic objects are loaded from database **225** for a specific user. These calculated IDs may not be saved at database **225**. For example, there may be a unique 0U0 ID for each dynamic object that is stored in the

standard_entity_data_id column within the standard_entity_data table. This allows a user to uniquely refer to an MCO from a feeds item, etc.

In one embodiment, a user, via user interface **244** provided through client-based application **242** at client computing device **240**, may generate dynamic objects (and may use them with administered objects) to manipulate and view data and related metadata in a particular format (e.g., table, etc.) as desired or necessitated by the user. Examples of users may include, but are not limited to, customers, such as organizational customers (e.g., small and large businesses, companies, corporations, academic institutions, government agencies, non-profit organization, etc.) of a service provider (e.g., Salesforece.com) and/or individual customers, such as individuals or end-users, of the organization customers. It is to be noted that terms like "user", "customer", "organization", "business", "company", etc., may be used interchangeably throughout this document.

For example and in one embodiment, dynamic objects may differ from administered custom objects in several ways, such as dynamic objects may (1) have virtually unlimited key space, they are (2) not residual in memory, (3) not cached, and (4) are considered user data. With regard to unlimited key space, for example, administered objects may have a keyspace of roughly, for example, 4000, so any database tenant may have only 4000 objects defined (or even limited to 2000). The administered object limit of 2000, for example, may be due to the limited reserved area of memory in the residual memory which holds these administered custom objects. Dynamic object-based tables may have a virtually unlimited keyspace (such as, not limited to, in the billions), so instead of two character designation, they may have a full 15 character ID, which means a virtually unlimited number of dynamic objects may be given to any given tenant. Further, dynamic objects, in one embodiment, are transient and thus, for each request, additional memory is created and then released at the end of the request. Using this technique, no restrictions or limits are imposed on the newly-created dynamic objects.

Additionally, in on embodiment, any metadata for dynamic objects is not cached and instead, the metadata is fetched along with the corresponding data whenever a request is placed or received. Without having to continuously cache metadata, a potentially unlimited number of dynamic objects may be created. With regard to user data, setup data is distinguished from non-setup or user data, such as administered objects, user profiles, etc., may be considered setup data, while accounts, leads, opportunities, etc., are considered non-setup or user data. Similarly, table definitions may be considered user data to be distinguished from any other metadata.

In one embodiment, dynamic objects mechanism **110** may be employed at a server computing system, such as computing device **100** of FIG. **1**, and may be in communication with one or more client computing devices, such as client computing device **240**, over a network, such as network **230** (e.g., a cloud-based network, the Internet, etc.). As aforementioned, a user may include an organization or organizational customer, such as a company, a business, etc., that is a customer to a provider (e.g., Salesforce.com) that provides access to dynamic objects mechanism **110** (such as via client computer **240**). Similarly, a user may further include an individual or a small business, etc., that is a customer of the organization/organizational customer and accesses dynamic objects mechanism **110** via another client computing device. Client computing device **240** may be the same as or similar to computing device **100** of FIG. **1** and include a mobile computing device (e.g., smartphones, tablet computers, etc.) or larger computers (e.g., desktop computers, server computers, etc.).

In one embodiment, dynamic objects mechanism **110** facilitates generation and use of dynamic objects (e.g., lightweight objects) along with administered objects to allow the user to manipulate, share, and present data/metadata any number of products, such as databases, social/business network websites, etc. For example, the technique may be applied to any number and type of social and business networking products, such as Chatter® by Salesforce.com, Facebook®, LinkedIn®, etc. Further, for example, using dynamic objects, instead of separately emailing a spreadsheet to each member of a group (e.g., accounting depart) of a company or organization, a member may choose to share data using a spreadsheet in a particular format (e.g., Excel® by Microsoft®, Numbers® by Apple®) on a business networking website (e.g., Chatter, etc.) with all or some members of the group even if the networking website does not typically support spreadsheets or particular forms of spreadsheets. In one embodiment, this is achieved by using dynamic objects mechanism **110** to generate the necessary number and type of dynamic objects (that support the spreadsheet) to work with the administered objects (already supported by the website) so that the spreadsheet may be shared and displayed on the website. It is contemplated that embodiments are not limited to any particular product, software application, website, such as Chatter, LinkedIn, Facebook, etc., just as the data/metadata is not limited to any particular product/format, such as spreadsheets (e.g., Excel, Numbers, etc.), word processing applications (e.g., Word® by Microsoft, Pages® by Apple, etc.), presentation applications (e.g., PowerPoint® by Microsoft, Keynote® by Apple, etc.), browsers (e.g., Explorer® by Microsoft, Safari® by Apple, etc.), etc.

In the illustrated embodiment, dynamic objects mechanism **110** may include various components, such as authentication logic **202**, request reception logic **204**, processing logic **206** (including detection module **208** having scanner **209**, decision module **210**, creation module **212**, import module **214**, conversion module **216**), reporting logic **218**, communication/access logic **220**, and compatibility logic **222**. Dynamic objects mechanism **110** is in communication with database **225** to store data and metadata relating to administered and dynamic objects. Object mechanism **110** is further in communication with any number and type of client computing devices, such as client computing device **240** over network **230**. Throughout this document, the term "logic" may be interchangeably referred to as "component" or "module" and may include, by way of example, software, hardware, and/or any combination of software and hardware, such as firmware. This combination of components provided through dynamic objects mechanism **110** facilitates user-based control and manipulation of particular data products/software applications (e.g., social websites, business websites, word processing, spreadsheets, database products, etc.) to be manipulated, shared, communicated, and displayed in any number and type of formats as desired or necessitated by user and communicated through user interface **244** at client computing device **240** and over network **230**.

In one embodiment, authentication logic **202** may be used to authenticate a user/customer and/or computing device **240** before the user is allowed to access and use dynamic objects mechanism **110**. It is contemplated that in some embodiments, the authentication process may be a one-time process conducted when computing device **240** is first allowed access to dynamic objects mechanism **110** or, in some embodiments, authentication may be a recurring process that is performed

each time a request for creating and/or using a dynamic object (is placed via computing device **240** and further via user interface **244**) is received by request reception logic **204** at components mechanism **110** at the cloud-based server computer over network **230**.

Once the request to generate one or more dynamic objects is received at request reception logic **204**, it is then sent to processing logic **206** for processing so that the dynamic objects may be generated and properly applied. For example, placing or receiving a request for creating dynamic objects may include having a user (e.g., accounting manager at a company, etc.) place a request to share data/metadata (e.g., company annual report) with other individuals at the company (e.g., accounting group, Central Financial Officer (CFO), etc.) using a software product (e.g., Excel spreadsheet) that is not supported by a website or business application (e.g., Chatter). In other words, for example, when a user requests a particular format or product to share, communicate, display or use data/metadata on a business application/website, the request may be interpreted as a request to generate a necessary set of dynamic objects so that the requested format may be supported by the business application/website, which is not typically supported by the administered objects of that business application/website. It is contemplated that the newly-generated set of dynamic objects may work with any administered objects to accomplish the aforementioned task of using the particular format or product.

In one embodiment, detection module **208** may be used to review the request to determine the requested data types (e.g., dates, numbers, text, etc.) within the request so that a determination may be made as to whether the requested data types may be supported or provided in database **225** or imported. Detection module **208** may include scanner **208** to not only scan various parts of the request, but also to scan any data/metadata for data types when the data/metadata is uploaded from database **225**. Database **225** may be accessed by and its uploading may be triggered using communication/access logic **220**. In one embodiment, once detection and the subsequent scanning is completed by detection module **208** and its scanner **209**, decision module **210** determines and decides whether the requested data types are available or may be imported and that any necessary dynamic objects may be created to support the requested data types to facilitate the user-requested format/product.

Upon determining that the relevant data types for the requested format are accessible, the corresponding dynamic objects may be created using creation module **212**. The newly-created dynamic objects may then be used with any custom objects to satisfy the user request for the particular format. In one embodiment, import module **214** may be used to important any number of entities, such as data types, data, metadata, objects, etc. This importation may be local, such as import module **214** may work with communication/access logic **220** to obtain any number and type of entities from database **225**, such as accessing an entity (e.g., data) directly from database **225** or through another entity, such as through a report (e.g., metadata relating to the data from a report), etc., residing at database **225**. The importation may be remote, such as obtaining any number and type of entities from any number and type of remote sources, such as another database or server computer, etc., in communication with the computing device employing dynamic objects mechanism **110** over network **230**.

Further, conversion module **216** may be used to perform various types of conversions, such as converting one data type to another (e.g., from text to number, etc.), converting formats, converting objects, etc. Dynamic objects mechanism **110** further includes reporting logic **218** to facilitate reporting-related tasks, such as generating reports (e.g., default reports, customized reports, etc.), copying reports, deleting reports, amending reports, etc. Compatibility logic **222** allows for dynamic objects mechanism **110** to work with any number and types of data types, software products, client computing devices **240**, networks **230**, and the like.

It is contemplated that any number and type of components may be added to and/or removed from dynamic objects mechanism **110** to facilitate various embodiments including adding, removing, and/or enhancing certain features. For brevity, clarity, and ease of understanding of dynamic objects mechanism **110**, many of the standard and/or known components, such as those of a computing device, are not shown or discussed here. It is contemplated that embodiments are not limited to any particular technology, topology, system, architecture, and/or standard and are dynamic enough to adopt and adapt to any future changes.

FIG. **3** illustrates a transaction sequence **300** for facilitating management and customization of lightweight objects according to one embodiment. Transaction sequence **300** may be performed by processing logic that may comprise hardware (e.g., circuitry, dedicated logic, programmable logic, etc.), software (such as instructions run on a processing device), or a combination thereof. In one embodiment, transaction sequence **300** may be performed by dynamic objects mechanism **110** of FIG. **1**.

In the illustrated embodiment, transaction sequence **300** begins with a user accessing a user interface **244** (e.g., an Internet browser, such as Explorer, Safari, etc.) at a client computing device for placing a request **305** for data any associated metadata (e.g., accounting report having the data/metadata) to be provided in a specific format (e.g., Excel, Word, etc.) using a software product (e.g., Chatter, Facebook, etc.). The request is received and processed **310** at objects mechanism **110** employed at a server computing device that is in communication with the client computing device over a network (e.g., cloud-based network, the Internet, etc.). The processing of the request may include generating new dynamic lightweight objects if the default or administered objects provided by the service provider (e.g., owner/provider of the software product, such as Salesforce.com providing Chatter) do not support the requested format.

Upon processing the request and generating the new dynamic objects, the requested data/metadata (including associated data types) is accessed **315** from database **225** (maintain Table data, Table metadata, etc.). The requested data/metadata is received **320** from database **225**. The data/metadata is processed **325** so it may be provided in the request format and upon processing, the data/metadata is provided in the requested format **330**, such as sharing an accounting spreadsheet in Excel format with various members of an accounting group by posting the spreadsheet using the software product (such as on Chatter, Facebook, etc.).

FIG. **4** illustrates a method **400** for facilitating management and customization of lightweight objects according to one embodiment. Method **400** may be performed by processing logic that may comprise hardware (e.g., circuitry, dedicated logic, programmable logic, etc.), software (such as instructions run on a processing device), or a combination thereof. In one embodiment, method **400** may be performed by dynamic objects mechanism **110** of FIG. **1**.

Method **400** begins with receiving a request, at block **405**, placed by a user by accessing a user interface (e.g., an Internet browser, such as Explorer, Safari, etc.) at a client computing device for data and any associated metadata (e.g., accounting report having the data/metadata) to be provided in a specific

format (e.g., Excel, Word, etc.) using a software product/website (e.g., Chatter, Facebook, etc.). The request is received and processed at objects mechanism **110** of FIG. **1** that may be employed at a server computing device that is in communication with the client computing device over a network (e.g., cloud-based network, the Internet, etc.). The processing of the request may include generating new dynamic lightweight objects if the default or administered objects provided by the service provider (e.g., owner/provider of the software product, such as Salesforce.com providing Chatter) do not support the requested format.

At block **410**, a determination is made as to whether the requested format is supported by the administered objects of the service provider. If yes, at block **415**, the process continues with using the relevant default or administered objects for generating the requested format. At block **425**, the process further continues with accessing the requested data/metadata from a local or remote database in communication with the server computing device so that the data/metadata may be put into the requested format and provided to the user at the client computing device. At block **430**, the requested data/metadata is provided via the requested format using the administered objects. As aforementioned, the providing of the data/metadata may include, but is not limited to, posting or sharing a file (having the data/metadata) on the requested software product/website via the requested format.

Referring back to block **410**, if the administered objects do not support the requested format, dynamic lightweight objects are generated at block **420**. At block **425**, the requested data/metadata is accessed at the database. The newly-generated lightweight objects are used to generate the requested format so that the requested data/metadata may be provided in the requested format. It is contemplated that to achieve the task of supporting the requested format, certain default/administered objects may also be used or employed to provide default functionalities for which there may not be any need to generate new objects. At block **430**, the requested data/metadata is provided via the requested format.

Referring to FIG. **8**, it illustrates detecting and evaluating a data type in an input data file for generating relevant lightweight dynamic custom objects according to one embodiment. In the illustrated embodiment, when an input data file is uploaded from a database, such as database **225** of FIG. **2**, detection module **208** (scanner **209**) is triggered to detect the various data types **832-838** in columns **842-846** of the uploaded file. For example, data types may include, but are not limited to, lookup **832**, date **834**, number **836**, text **838** (serving as the default data type), etc. In one embodiment, columns **842-846** of the data may be scanned, via scanner **209**, to determine or detect the various data types **832-838**.

For example and as illustrated, at block **802**, column **842** is scanned to determine whether the data type of column **842** is an ID or a record name. If yes, at block **822**, a determination is made as to whether there are any additional rows so they may also be similarly checked. If there are no more rows, the data type is classified or interpreted as lookup **832**. At block **822**. If there are additional rows, the process continues with reading the additional rows at block **812**, followed by a determination of the data type classification at block **802**. If, at block **802**, for any row, it is determined that the data type is neither an ID nor a record name, the process continues at the next column **844** with decision block **804** with another determination.

At block **804**, a determination is made as to whether the data type is a date. If yes, at block **824**, a determination is made as to whether there are any additional rows to be evaluated. If not, the data type is classified as date **834**. If there are additional rows, the process continues with reading the next row and any subsequent rows at block **814** and then moves on to perform another determination at block **804** as to whether the data type of these additional rows is a date. If not, the process continues with the next column **846** with another determination at block **806**.

At block **806**, a determination is made as to whether the data type is a number. If yes, at block **826**, a determination is made as to whether there are any additional rows to be evaluated. If not, the data type is classified as number **836**. If there are additional rows, the process continues with reading the next row and any subsequent rows at block **816** and then moves on to perform another determination at block **806** as to whether the data type of these additional rows is a number. If not, the process continues with classifying the data type as text **838**, which serves as a default data type.

In one embodiment, dynamic lightweight custom objects may be instantiated from the input data containing any number of columns **842-846** and rows. In one embodiment, detection module **208** in combination with scanner **209** my detect data types **832-838** by scanning or inspecting columns **842-846** to determine whether they fit into a particular data type, such as relationship/lookup **832**, date **834**, number **836**, text **838**, etc. Once a data type **832-838** for each column **842-846** has been identified, dynamic objects mechanism **110** of FIG. **1** generates the corresponding dynamic lightweight objects using strongly-typed fields based on the input data. Further, a user interface may be used for uploading the data into the newly-generated dynamic objects and it is contemplated that multiple input data types and locales (e.g., CVS, TSV, XLS, etc.) may be supported. Additionally, source file formats may be parsed to determine field types, while data may be imported in a bulk insert.

In one embodiment, detection module **208** (scanner **209**) of FIG. **2** may be used to keep trace of whether a dynamic object is available for use, is in progress, has failed, etc., and to surface that information in the UI. In some embodiments, an ENUM field may be added to a dynamic object entity. These values may include: (1) NEW, which is set to the record or entity when the corresponding dynamic object is newly created, while the corresponding dynamic object record may be created in the same transaction as the enqueue event; (2) IN PROGRESS, which may be the first thing a message queue handler may do when dequeueing a message is to set the dynamic object status to IN PROGRESS and commit that change (e.g., using a second connection, if necessary); (3) FAILED may be set when there has been an irreconcilable error after a number of attempts (e.g., 3 or 4 attempts, etc.) have been made; and (4) SUCCESS may be set after a queue message has been processed and the relevant data has been imported in a table (e.g., core.my_entity_data).

FIGS. **9**A and **9**B illustrate processes **900**, **950** in accordance with FIG. **8** according to one embodiment. FIG. **9**A illustrates a process **900** that begins with obtaining data by uploading an input data file **905**. It is contemplated that in some embodiments, the input data may not be uploaded and instead, it may be obtained from an existing data report stored within the system, such as at a database. For example, reports may have an export to cvs process that may be leveraged to create the input data. In one embodiment, once the input data **905** has been uploaded, various data types are detected and classified at block **910** as described with reference to FIG. **8**. Upon detection of the data types and their corresponding classifications, metadata associated with the data is created at block **915**. The data and associated metadata are stored at

database **225**. The process of metadata creation may include generating a set of dynamic lightweight objects based on the data types classifications.

FIG. **9**B illustrates a process **950** that beings with obtaining data by uploading an input data file **905**, while metadata **965** is appended or imported, at block **960**, having newly-generated dynamic lightweight objects that is then stored at database **225**. The data/metadata import, at block **960**, may be performed using import module **214** of FIG. **2**.

In one embodiment, import module **214** of FIG. **2** may facilitate import of input data files **955**, while further facilitating a validation process for validate the imported and other input data files **905**, **955**, performing an automatic data type check, etc. Data files **955** may be imported synchronously or asynchronously based on any number of factors, such as file size, import results, e-mail messages, etc. In one embodiment, the process may include determining the size of data within a data file **955** to be imported as an object (e.g., dynamic lightweight object), uploading the set of data based on the size of the data, and if the size is small, the uploading process may be performed synchronously, while if the size is large, the uploading process may be performed asynchronously.

In some embodiments, a user, via a user interface at a computing device, such as user interface **244** at computing device **240** of FIG. **2**, may automatically create a new table based on contents of an input file **905**, **955**. Alternatively, in some embodiments, the user may be allowed to create a table from scratch, such as similar to the process of importing data, at block **960**, by, for example, having define contents and scope of the table (without having the necessity for employing the imported data evaluation process). The process may include prompting a user, via a user interface at a computing device, such as user interface **244** at computing device **240** of FIG. **2**, for a providing a table definition for generating a table. The user's provided definition is received as a request at request reception logic **204** of FIG. **2**, while the request is processed by dynamic objects mechanism **110** and the table is generated based on the table definition.

In some embodiments, a user, via a user interface at a computing device, such as user interface **244** at computing device **240** of FIG. **2**, may automatically create a new table based on contents of an input file **905**, **955**, while the table may be created from a report, such as based on a report's definition and the underlying queried data. Further, in one embodiment, the report's metadata and the queried data may be transformed into a physical table that includes the report data. The transformation may be performed by, for example, parsing the report to identify columns and/or other subsets of the report data and then, automatically, defining column names with their correct data types, correct names, etc., while the report data may be automatically imported in to table. The table may then be provided to the user in response to the request placed by the user, such as by displaying the table via a software application, such as a social or business network website (e.g., Chatter, Facebook, etc.). For example, the process may include receiving a report at an on-demand services database, parsing the report into subsets of data, and generating a table based on the subsets of the data.

Furthermore, in one embodiment, a user may be allowed to upsert (e.g., upload and/or insert) data into an existing table; for example, if an Excel file is used to create dynamic lightweight objects, dynamic objects mechanism **110** of FIG. **1** may facilitate the user the ability to upsert the same file (or other files, data from external data sources, etc.) in the same table. For example and in one embodiment, the process may include receiving a data file to upsert into a dynamic lightweight object of an on-demand services database, and upserting contents of the data file into the dynamic lightweight object.

Referring now to FIG. **5**, it illustrates a diagrammatic representation of a machine **500** in the exemplary form of a computer system, in accordance with one embodiment, within which a set of instructions, for causing the machine **500** to perform any one or more of the methodologies discussed herein, may be executed. Machine **500** is the same as or similar to computing device **100** and computing device **240** of FIG. **1** and FIG. **2**, respectively. In alternative embodiments, the machine may be connected (e.g., networked) to other machines in a network (such as host machine **100** of FIG. **1** connected with client machine **240** of FIG. **2** over network **230**), such as a cloud-based network, a Local Area Network (LAN), a Wide Area Network (WAN), a Metropolitan Area Network (MAN), a Personal Area Network (PAN), an intranet, an extranet, or the Internet. The machine may operate in the capacity of a server or a client machine in a client-server network environment, or as a peer machine in a peer-to-peer (or distributed) network environment or as a server or series of servers within an on-demand service environment, including an on-demand environment providing multi-tenant database storage services. Certain embodiments of the machine may be in the form of a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a server, a network router, switch or bridge, computing system, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines (e.g., computers) that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein.

The exemplary computer system **500** includes a processor **502**, a main memory **504** (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) such as synchronous DRAM (SDRAM) or Rambus DRAM (RDRAM), etc., static memory such as flash memory, static random access memory (SRAM), volatile but high-data rate RAM, etc.), and a secondary memory **518** (e.g., a persistent storage device including hard disk drives and persistent multi-tenant data base implementations), which communicate with each other via a bus **530**. Main memory **504** includes emitted execution data **524** (e.g., data emitted by a logging framework) and one or more trace preferences **523** which operate in conjunction with processing logic **526** and processor **502** to perform the methodologies discussed herein.

Processor **502** represents one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. More particularly, the processor **502** may be a complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, processor implementing other instruction sets, or processors implementing a combination of instruction sets. Processor **502** may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. Processor **502** is configured to execute the processing logic **526** for performing the operations and functionality of dynamic objects mechanism **110** as described with reference to FIG. **1** and other figures discussed herein.

The computer system **500** may further include a network interface card **508**. The computer system **500** also may

include a user interface **510** (such as a video display unit, a liquid crystal display (LCD), or a cathode ray tube (CRT)), an alphanumeric input device **512** (e.g., a keyboard), a cursor control device **514** (e.g., a mouse), and a signal generation device **516** (e.g., an integrated speaker). The computer system **500** may further include peripheral device **536** (e.g., wireless or wired communication devices, memory devices, storage devices, audio processing devices, video processing devices, etc. The computer system **500** may further include a Hardware based API logging framework **534** capable of executing incoming requests for services and emitting execution data responsive to the fulfillment of such incoming requests.

The secondary memory **518** may include a machine-readable storage medium (or more specifically a machine-accessible storage medium) **531** on which is stored one or more sets of instructions (e.g., software **522**) embodying any one or more of the methodologies or functions of dynamic objects mechanism **110** as described with reference to FIG. **1** and other figures described herein. The software **522** may also reside, completely or at least partially, within the main memory **504** and/or within the processor **502** during execution thereof by the computer system **500**, the main memory **504** and the processor **502** also constituting machine-readable storage media. The software **522** may further be transmitted or received over a network **520** via the network interface card **508**. The machine-readable storage medium **531** may include transitory or non-transitory machine-readable storage media.

Portions of various embodiments may be provided as a computer program product, which may include a computer-readable medium having stored thereon computer program instructions, which may be used to program a computer (or other electronic devices) to perform a process according to the embodiments. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, compact disk read-only memory (CD-ROM), and magneto-optical disks, ROM, RAM, erasable programmable read-only memory (EPROM), electrically EPROM (EEPROM), magnet or optical cards, flash memory, or other type of media/machine-readable medium suitable for storing electronic instructions.

The techniques shown in the figures can be implemented using code and data stored and executed on one or more electronic devices (e.g., an end station, a network element). Such electronic devices store and communicate (internally and/or with other electronic devices over a network) code and data using computer-readable media, such as non-transitory computer-readable storage media (e.g., magnetic disks; optical disks; random access memory; read only memory; flash memory devices; phase-change memory) and transitory computer-readable transmission media (e.g., electrical, optical, acoustical or other form of propagated signals—such as carrier waves, infrared signals, digital signals). In addition, such electronic devices typically include a set of one or more processors coupled to one or more other components, such as one or more storage devices (non-transitory machine-readable storage media), user input/output devices (e.g., a keyboard, a touchscreen, and/or a display), and network connections. The coupling of the set of processors and other components is typically through one or more busses and bridges (also termed as bus controllers). Thus, the storage device of a given electronic device typically stores code and/or data for execution on the set of one or more processors of that electronic device. Of course, one or more parts of an embodiment may be implemented using different combinations of software, firmware, and/or hardware.

FIG. **6** illustrates a block diagram of an environment **610** wherein an on-demand database service might be used. Environment **610** may include user systems **612**, network **614**, system **616**, processor system **617**, application platform **618**, network interface **620**, tenant data storage **622**, system data storage **624**, program code **626**, and process space **628**. In other embodiments, environment **610** may not have all of the components listed and/or may have other elements instead of, or in addition to, those listed above.

Environment **610** is an environment in which an on-demand database service exists. User system **612** may be any machine or system that is used by a user to access a database user system. For example, any of user systems **612** can be a handheld computing device, a mobile phone, a laptop computer, a work station, and/or a network of computing devices. As illustrated in herein FIG. **6** (and in more detail in FIG. **7**) user systems **612** might interact via a network **614** with an on-demand database service, which is system **616**.

An on-demand database service, such as system **616**, is a database system that is made available to outside users that do not need to necessarily be concerned with building and/or maintaining the database system, but instead may be available for their use when the users need the database system (e.g., on the demand of the users). Some on-demand database services may store information from one or more tenants stored into tables of a common database image to form a multi-tenant database system (MTS). Accordingly, "on-demand database service **616**" and "system **616**" will be used interchangeably herein. A database image may include one or more database objects. A relational database management system (RDMS) or the equivalent may execute storage and retrieval of information against the database object(s). Application platform **618** may be a framework that allows the applications of system **616** to run, such as the hardware and/or software, e.g., the operating system. In an embodiment, on-demand database service **616** may include an application platform **618** that enables creation, managing and executing one or more applications developed by the provider of the on-demand database service, users accessing the on-demand database service via user systems **612**, or third party application developers accessing the on-demand database service via user systems **612**.

The users of user systems **612** may differ in their respective capacities, and the capacity of a particular user system **612** might be entirely determined by permissions (permission levels) for the current user. For example, where a salesperson is using a particular user system **612** to interact with system **616**, that user system has the capacities allotted to that salesperson. However, while an administrator is using that user system to interact with system **616**, that user system has the capacities allotted to that administrator. In systems with a hierarchical role model, users at one permission level may have access to applications, data, and database information accessible by a lower permission level user, but may not have access to certain applications, database information, and data accessible by a user at a higher permission level. Thus, different users will have different capabilities with regard to accessing and modifying application and database information, depending on a user's security or permission level.

Network **614** is any network or combination of networks of devices that communicate with one another. For example, network **614** can be any one or any combination of a LAN (local area network), WAN (wide area network), telephone network, wireless network, point-to-point network, star network, token ring network, hub network, or other appropriate configuration. As the most common type of computer network in current use is a TCP/IP (Transfer Control Protocol and Internet Protocol) network, such as the global internetwork of networks often referred to as the "Internet" with a

capital "I," that network will be used in many of the examples herein. However, it should be understood that the networks that one or more implementations might use are not so limited, although TCP/IP is a frequently implemented protocol.

User systems **612** might communicate with system **616** using TCP/IP and, at a higher network level, use other common Internet protocols to communicate, such as HTTP, FTP, AFS, WAP, etc. In an example where HTTP is used, user system **612** might include an HTTP client commonly referred to as a "browser" for sending and receiving HTTP messages to and from an HTTP server at system **616**. Such an HTTP server might be implemented as the sole network interface between system **616** and network **614**, but other techniques might be used as well or instead. In some implementations, the interface between system **616** and network **614** includes load sharing functionality, such as round-robin HTTP request distributors to balance loads and distribute incoming HTTP requests evenly over a plurality of servers. At least as for the users that are accessing that server, each of the plurality of servers has access to the MTS' data; however, other alternative configurations may be used instead.

In one embodiment, system **616**, shown in FIG. **6**, implements a web-based customer relationship management (CRM) system. For example, in one embodiment, system **616** includes application servers configured to implement and execute CRM software applications as well as provide related data, code, forms, webpages and other information to and from user systems **612** and to store to, and retrieve from, a database system related data, objects, and Webpage content. With a multi-tenant system, data for multiple tenants may be stored in the same physical database object, however, tenant data typically is arranged so that data of one tenant is kept logically separate from that of other tenants so that one tenant does not have access to another tenant's data, unless such data is expressly shared. In certain embodiments, system **616** implements applications other than, or in addition to, a CRM application. For example, system **616** may provide tenant access to multiple hosted (standard and custom) applications, including a CRM application. User (or third party developer) applications, which may or may not include CRM, may be supported by the application platform **618**, which manages creation, storage of the applications into one or more database objects and executing of the applications in a virtual machine in the process space of the system **616**.

One arrangement for elements of system **616** is shown in FIG. **6**, including a network interface **620**, application platform **618**, tenant data storage **622** for tenant data **623**, system data storage **624** for system data **625** accessible to system **616** and possibly multiple tenants, program code **626** for implementing various functions of system **616**, and a process space **628** for executing MTS system processes and tenant-specific processes, such as running applications as part of an application hosting service. Additional processes that may execute on system **616** include database indexing processes.

Several elements in the system shown in FIG. **6** include conventional, well-known elements that are explained only briefly here. For example, each user system **612** could include a desktop personal computer, workstation, laptop, PDA, cell phone, or any wireless access protocol (WAP) enabled device or any other computing device capable of interfacing directly or indirectly to the Internet or other network connection. User system **612** typically runs an HTTP client, e.g., a browsing program, such as Microsoft's Internet Explorer browser, Netscape's Navigator browser, Opera's browser, or a WAP-enabled browser in the case of a cell phone, PDA or other wireless device, or the like, allowing a user (e.g., subscriber of the multi-tenant database system) of user system **612** to access, process and view information, pages and applications available to it from system **616** over network **614**. Each user system **612** also typically includes one or more user interface devices, such as a keyboard, a mouse, trackball, touch pad, touch screen, pen or the like, for interacting with a graphical user interface (GUI) provided by the browser on a display (e.g., a monitor screen, LCD display, etc.) in conjunction with pages, forms, applications and other information provided by system **616** or other systems or servers. For example, the user interface device can be used to access data and applications hosted by system **616**, and to perform searches on stored data, and otherwise allow a user to interact with various GUI pages that may be presented to a user. As discussed above, embodiments are suitable for use with the Internet, which refers to a specific global internetwork of networks. However, it should be understood that other networks can be used instead of the Internet, such as an intranet, an extranet, a virtual private network (VPN), a non-TCP/IP based network, any LAN or WAN or the like.

According to one embodiment, each user system **612** and all of its components are operator configurable using applications, such as a browser, including computer code run using a central processing unit such as an Intel Pentium® processor or the like. Similarly, system **616** (and additional instances of an MTS, where more than one is present) and all of their components might be operator configurable using application(s) including computer code to run using a central processing unit such as processor system **617**, which may include an Intel Pentium® processor or the like, and/or multiple processor units. A computer program product embodiment includes a machine-readable storage medium (media) having instructions stored thereon/in which can be used to program a computer to perform any of the processes of the embodiments described herein. Computer code for operating and configuring system **616** to intercommunicate and to process webpages, applications and other data and media content as described herein are preferably downloaded and stored on a hard disk, but the entire program code, or portions thereof, may also be stored in any other volatile or non-volatile memory medium or device as is well known, such as a ROM or RAM, or provided on any media capable of storing program code, such as any type of rotating media including floppy disks, optical discs, digital versatile disk (DVD), compact disk (CD), microdrive, and magneto-optical disks, and magnetic or optical cards, nanosystems (including molecular memory ICs), or any type of media or device suitable for storing instructions and/or data. Additionally, the entire program code, or portions thereof, may be transmitted and downloaded from a software source over a transmission medium, e.g., over the Internet, or from another server, as is well known, or transmitted over any other conventional network connection as is well known (e.g., extranet, VPN, LAN, etc.) using any communication medium and protocols (e.g., TCP/IP, HTTP, HTTPS, Ethernet, etc.) as are well known. It will also be appreciated that computer code for implementing embodiments can be implemented in any programming language that can be executed on a client system and/or server or server system such as, for example, C, C++, HTML, any other markup language, Java™, JavaScript, ActiveX, any other scripting language, such as VBScript, and many other programming languages as are well known may be used. (Java™ is a trademark of Sun Microsystems, Inc.).

According to one embodiment, each system **616** is configured to provide webpages, forms, applications, data and media content to user (client) systems **612** to support the access by user systems **612** as tenants of system **616**. As such, system **616** provides security mechanisms to keep each ten-

ant's data separate unless the data is shared. If more than one MTS is used, they may be located in close proximity to one another (e.g., in a server farm located in a single building or campus), or they may be distributed at locations remote from one another (e.g., one or more servers located in city A and one or more servers located in city B). As used herein, each MTS could include one or more logically and/or physically connected servers distributed locally or across one or more geographic locations. Additionally, the term "server" is meant to include a computer system, including processing hardware and process space(s), and an associated storage system and database application (e.g., OODBMS or RDBMS) as is well known in the art. It should also be understood that "server system" and "server" are often used interchangeably herein. Similarly, the database object described herein can be implemented as single databases, a distributed database, a collection of distributed databases, a database with redundant online or offline backups or other redundancies, etc., and might include a distributed database or storage network and associated processing intelligence.

FIG. **7** also illustrates environment **610**. However, in FIG. **7** elements of system **616** and various interconnections in an embodiment are further illustrated. FIG. **7** shows that user system **612** may include processor system **612**A, memory system **612**B, input system **612**C, and output system **612**D. FIG. **7** shows network **614** and system **616**. FIG. **7** also shows that system **616** may include tenant data storage **622**, tenant data **623**, system data storage **624**, system data **625**, User Interface (UI) **730**, Application Program Interface (API) **732**, PL/SOQL **734**, save routines **736**, application setup mechanism **738**, applications servers $\mathbf{700}_1$-$\mathbf{700}_N$, system process space **702**, tenant process spaces **704**, tenant management process space **710**, tenant storage area **712**, user storage **714**, and application metadata **716**. In other embodiments, environment **610** may not have the same elements as those listed above and/or may have other elements instead of, or in addition to, those listed above.

User system **612**, network **614**, system **616**, tenant data storage **622**, and system data storage **624** were discussed above in FIG. **6**. Regarding user system **612**, processor system **612**A may be any combination of one or more processors. Memory system **612**B may be any combination of one or more memory devices, short term, and/or long term memory. Input system **612**C may be any combination of input devices, such as one or more keyboards, mice, trackballs, scanners, cameras, and/or interfaces to networks. Output system **612**D may be any combination of output devices, such as one or more monitors, printers, and/or interfaces to networks. As shown by FIG. **7**, system **616** may include a network interface **620** (of FIG. **6**) implemented as a set of HTTP application servers **700**, an application platform **618**, tenant data storage **622**, and system data storage **624**. Also shown is system process space **702**, including individual tenant process spaces **704** and a tenant management process space **710**. Each application server **700** may be configured to tenant data storage **622** and the tenant data **623** therein, and system data storage **624** and the system data **625** therein to serve requests of user systems **612**. The tenant data **623** might be divided into individual tenant storage areas **712**, which can be either a physical arrangement and/or a logical arrangement of data. Within each tenant storage area **712**, user storage **714** and application metadata **716** might be similarly allocated for each user. For example, a copy of a user's most recently used (MRU) items might be stored to user storage **714**. Similarly, a copy of MRU items for an entire organization that is a tenant might be stored to tenant storage area **712**. A UI **730** provides a user interface and an API **732** provides an application programmer interface to system **616** resident processes to users and/or developers at user systems **612**. The tenant data and the system data may be stored in various databases, such as one or more Oracle™ databases.

Application platform **618** includes an application setup mechanism **738** that supports application developers' creation and management of applications, which may be saved as metadata into tenant data storage **622** by save routines **736** for execution by subscribers as one or more tenant process spaces **704** managed by tenant management process **710** for example. Invocations to such applications may be coded using PL/SOQL **734** that provides a programming language style interface extension to API **732**. A detailed description of some PL/SOQL language embodiments is discussed in commonly owned U.S. Pat. No. 7,730,478 entitled, "Method and System for Allowing Access to Developed Applicants via a Multi-Tenant Database On-Demand Database Service"—issued Jun. 1, 2010 to Craig Weissman, which is incorporated in its entirety herein for all purposes. Invocations to applications may be detected by one or more system processes, which manage retrieving application metadata **716** for the subscriber making the invocation and executing the metadata as an application in a virtual machine.

Each application server **700** may be communicably coupled to database systems, e.g., having access to system data **625** and tenant data **623**, via a different network connection. For example, one application server $\mathbf{700}_1$ might be coupled via the network **614** (e.g., the Internet), another application server $\mathbf{700}_{N-1}$ might be coupled via a direct network link, and another application server $\mathbf{700}_N$ might be coupled by yet a different network connection. Transfer Control Protocol and Internet Protocol (TCP/IP) are typical protocols for communicating between application servers **700** and the database system. However, it will be apparent to one skilled in the art that other transport protocols may be used to optimize the system depending on the network interconnect used.

In certain embodiments, each application server **700** is configured to handle requests for any user associated with any organization that is a tenant. Because it is desirable to be able to add and remove application servers from the server pool at any time for any reason, there is preferably no server affinity for a user and/or organization to a specific application server **700**. In one embodiment, therefore, an interface system implementing a load balancing function (e.g., an F5 Big-IP load balancer) is communicably coupled between the application servers **700** and the user systems **612** to distribute requests to the application servers **700**. In one embodiment, the load balancer uses a least connections algorithm to route user requests to the application servers **700**. Other examples of load balancing algorithms, such as round robin and observed response time, also can be used. For example, in certain embodiments, three consecutive requests from the same user could hit three different application servers **700**, and three requests from different users could hit the same application server **700**. In this manner, system **616** is multi-tenant, wherein system **616** handles storage of, and access to, different objects, data and applications across disparate users and organizations.

As an example of storage, one tenant might be a company that employs a sales force where each salesperson uses system **616** to manage their sales process. Thus, a user might maintain contact data, leads data, customer follow-up data, performance data, goals and progress data, etc., all applicable to that user's personal sales process (e.g., in tenant data storage **622**). In an example of a MTS arrangement, since all of the data and the applications to access, view, modify, report, transmit, calculate, etc., can be maintained and accessed by a

user system having nothing more than network access, the user can manage his or her sales efforts and cycles from any of many different user systems. For example, if a salesperson is visiting a customer and the customer has Internet access in their lobby, the salesperson can obtain critical updates as to that customer while waiting for the customer to arrive in the lobby.

While each user's data might be separate from other users' data regardless of the employers of each user, some data might be organization-wide data shared or accessible by a plurality of users or all of the users for a given organization that is a tenant. Thus, there might be some data structures managed by system **616** that are allocated at the tenant level while other data structures might be managed at the user level. Because an MTS might support multiple tenants including possible competitors, the MTS should have security protocols that keep data, applications, and application use separate. Also, because many tenants may opt for access to an MTS rather than maintain their own system, redundancy, up-time, and backup are additional functions that may be implemented in the MTS. In addition to user-specific data and tenant specific data, system **616** might also maintain system level data usable by multiple tenants or other data. Such system level data might include industry reports, news, postings, and the like that are sharable among tenants.

In certain embodiments, user systems **612** (which may be client systems) communicate with application servers **700** to request and update system-level and tenant-level data from system **616** that may require sending one or more queries to tenant data storage **622** and/or system data storage **624**. System **616** (e.g., an application server **700** in system **616**) automatically generates one or more SQL statements (e.g., one or more SQL queries) that are designed to access the desired information. System data storage **624** may generate query plans to access the requested data from the database.

Each database can generally be viewed as a collection of objects, such as a set of logical tables, containing data fitted into predefined categories. A "table" is one representation of a data object, and may be used herein to simplify the conceptual description of objects and custom objects. It should be understood that "table" and "object" may be used interchangeably herein. Each table generally contains one or more data categories logically arranged as columns or fields in a viewable schema. Each row or record of a table contains an instance of data for each category defined by the fields. For example, a CRM database may include a table that describes a customer with fields for basic contact information such as name, address, phone number, fax number, etc. Another table might describe a purchase order, including fields for information such as customer, product, sale price, date, etc. In some multi-tenant database systems, standard entity tables might be provided for use by all tenants. For CRM database applications, such standard entities might include tables for Account, Contact, Lead, and Opportunity data, each containing pre-defined fields. It should be understood that the word "entity" may also be used interchangeably herein with "object" and "table".

In some multi-tenant database systems, tenants may be allowed to create and store custom objects, or they may be allowed to customize standard entities or objects, for example by creating custom fields for standard objects, including custom index fields. U.S. patent application Ser. No. 10/817,161, filed Apr. 2, 2004, entitled "Custom Entities and Fields in a Multi-Tenant Database System", and which is hereby incorporated herein by reference, teaches systems and methods for creating custom objects as well as customizing standard objects in a multi-tenant database system. In certain embodiments, for example, all custom entity data rows are stored in a single multi-tenant physical table, which may contain multiple logical tables per organization. It is transparent to customers that their multiple "tables" are in fact stored in one large table or that their data may be stored in the same table as the data of other customers.

Any of the above embodiments may be used alone or together with one another in any combination. Embodiments encompassed within this specification may also include embodiments that are only partially mentioned or alluded to or are not mentioned or alluded to at all in this brief summary or in the abstract. Although various embodiments may have been motivated by various deficiencies with the prior art, which may be discussed or alluded to in one or more places in the specification, the embodiments do not necessarily address any of these deficiencies. In other words, different embodiments may address different deficiencies that may be discussed in the specification. Some embodiments may only partially address some deficiencies or just one deficiency that may be discussed in the specification, and some embodiments may not address any of these deficiencies.

While one or more implementations have been described by way of example and in terms of the specific embodiments, it is to be understood that one or more implementations are not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements. It is to be understood that the above description is intended to be illustrative, and not restrictive.

What is claimed is:

1. A database system-implemented method, comprising:

importing, by the database system, one or more dynamic objects capable of being assigned to a default product accessible to a tenant in a multi-tenant environment, wherein the one or more dynamic objects are imported based on tenant preferences associated with the tenant;

associating, by the database system, the one or more dynamic objects with one or more default objects of the default product accessible the tenant; and

dynamically configuring, by the database system based on the tenant preferences, the default product based on a combination of the one or more dynamic objects and the one or more default objects, wherein dynamically configuring includes on-the-fly modifying of the default product into a customized product, wherein on-the-fly modifying includes on-the-fly loading of at least one of data and metadata associated with the default product without necessitating caching or displaying of irrelevant contents.

2. The method of claim **1**, further comprising displaying the customized product to a user representing the tenant, wherein the customized product includes customized data types relating to one or more formats of contents of the customized product, wherein the default and customized products include one or more software applications having one or more of tables, websites, business networking applications, and social networking applications.

3. The method of claim **1**, wherein a dynamic identifying space of a dynamic object is greater than a default identifying space of a default object to support the unlimited number of dynamic objects assigned to the tenant, wherein the tenant includes an organization having one or more of an institution, a business, a company, a corporation, a group, an individual, and an entity.

4. The method of claim 3, wherein the dynamic object further comprises an unlimited key space that includes user data and is not cached or residual in memory, wherein the default object comprises a limited key space.

5. The method of claim 1, further comprising:

determining a size of a set of data associated with the set of dynamic objects; and

uploading, based on the size, the dynamic objects, wherein uploading includes synchronous uploading if the size includes a small size, and wherein uploading includes an asynchronous uploading of the size includes a large size.

6. The method of claim 1, further comprising:

receiving an input file associated with the set of dynamic objects;

evaluating data in the input file to identify a data type of subset of the data; and

automatically creating one or more dynamic objects based on the evaluated data, wherein the one or more dynamic objects include fields to store the data, the fields having the data type corresponding to the subset of the data.

7. A system comprising:

a computing system having a processing device and a memory coupled with the processing device, wherein the memory to store instructions, and the processing device to execute the instructions to facilitate a mechanism to perform operations comprising:

importing one or more dynamic objects capable of being assigned to a default product accessible to a tenant in a multi-tenant environment, wherein the one or more dynamic objects are incorporated based on tenant preferences associated with the tenant;

associating the one or more dynamic objects with one or more default objects of the default product accessible the tenant; and

dynamically configuring, based on the tenant preferences, the default product based on a combination of the one or more dynamic objects and the one or more default objects, wherein dynamically configuring includes on-the-fly modifying of the default product into a customized product, wherein on-the-fly modifying includes on-the-fly loading of at least one of data and metadata associated with the default product without necessitating caching or displaying of irrelevant contents.

8. The system of claim 7, wherein the operations further comprise displaying the customized product to a user representing the tenant, wherein the customized product includes customized data types relating to one or more formats of contents of the customized product, wherein the default and customized products include one or more software applications having one or more of tables, websites, business networking applications, and social networking applications.

9. The system of claim 7, wherein a dynamic identifying space of a dynamic object is greater than a default identifying space of a default object to support the unlimited number of dynamic objects assigned to the tenant, wherein the tenant includes an organization having one or more of an institution, a business, a company, a corporation, a group, an individual, and an entity.

10. The system of claim 9, wherein the dynamic object further comprises an unlimited key space that includes user data and is not cached or residual in memory, wherein the default object comprises a limited key space.

11. The system of claim 7, wherein the operations further comprise:

determining a size of a set of data associated with the set of dynamic objects; and

uploading, based on the size, the dynamic objects, wherein uploading includes synchronous uploading if the size includes a small size, and wherein uploading includes an asynchronous uploading of the size includes a large size.

12. The system of claim 7, wherein the operations further comprise:

receiving an input file associated with the set of dynamic objects;

evaluating data in the input file to identify a data type of subset of the data; and

automatically creating one or more dynamic objects based on the evaluated data, wherein the one or more dynamic objects include fields to store the data, the fields having the data type corresponding to the subset of the data.

13. A non-transitory machine-readable medium having stored thereon instructions which, when executed by a machine, cause the machine to perform operations comprising:

importing one or more dynamic objects capable of being assigned to a default product accessible to a tenant in a multi-tenant environment, wherein the one or more dynamic objects are imported based on tenant preferences associated with the tenant;

associating the one or more dynamic objects with one or more default objects of the default product accessible to the tenant; and

dynamically configuring, based on the tenant preferences, the default product based on a combination of the one or more dynamic objects and the one or more default objects, wherein dynamically configuring includes on-the-fly modifying of the default product into a customized product, wherein on-the-fly modifying includes on-the-fly loading of at least one of data and metadata associated with the default product without necessitating caching or displaying of irrelevant contents.

14. The non-transitory machine-readable medium of claim 13, wherein the operations further comprise displaying the customized product to a user representing the tenant, wherein the customized product includes customized data types relating to one or more formats of contents of the customized product, wherein the default and customized products include one or more software applications having one or more of tables, websites, business networking applications, and social networking applications.

15. The non-transitory machine-readable medium of claim 13, wherein a dynamic identifying space of a dynamic object is greater than a default identifying space of a default object to support the unlimited number of dynamic objects assigned to the tenant, wherein the tenant includes an organization having one or more of an institution, a business, a company, a corporation, a group, an individual, and an entity.

16. The non-transitory machine-readable medium of claim 15, wherein the dynamic object further comprises an unlimited key space that includes user data and is not cached or residual in memory, wherein the default object comprises a limited key space.

17. The non-transitory machine-readable medium of claim 13, wherein the operations further comprise:

determining a size of a set of data associated with the set of dynamic objects; and

uploading, based on the size, the dynamic objects, wherein uploading includes synchronous uploading if the size includes a small size, and wherein uploading includes an asynchronous uploading of the size includes a large size.

18. The non-transitory machine-readable medium of claim 13, wherein the operations further comprise:

receiving an input file associated with the set of dynamic objects;

evaluating data in the input file to identify a data type of subset of the data; and

automatically creating one or more dynamic objects based on the evaluated data, wherein the one or more dynamic objects include fields to store the data, the fields having the data type corresponding to the subset of the data.

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